Mix Design & Production Control Recertification

Quality Control / Quality Assurance

SDDOT Employee Timesheet Information

Charge to Office Overhead

AFE – 71B7

Function - 1174

IMPORTANT

Recertification is only for individuals currently certified and actively participating on Asphalt Concrete Projects

Course Materials

- QC/QA Asphalt Concrete Training Manual
- Standard Specifications for Roads and Bridges (2015 Edition) - Sections 320 and 322
- South Dakota DOT Materials Manual - Minimum Sample and Test Requirements (MSTR)
- Example Problems Packet

Course Agenda

- Prior Changes
- Aggregate Requirements
- Flat & Elongated Problem
- Composites
- Mix Design Calculations
- Submittals
- SDDOT Verification
- Field Testing/Problems
- Potential Future Changes
- Recertification Exam

Prior Changes

- Dust to binder ratio - uses effective binder content and new limits (RAP)
- RAP allowed when specified (Research Project)
- Lime, if needed, added to aggregate with at least 1.0 percent moisture above aggr. SSD
- No TSR if 1.00% hydrated lime added
- Number 6 burner fuel is allowed but must furnish cert with each load delivered

Prior Changes

- Bin splits adjusted up to 5 percent to meet gradation, mix design and requirements
- Contractors and Consultants doing mix designs must participate in Round Robin testing (Sample Proficiency Program)
- APA specification on all mix designs

Prior Changes

- New gyratory compaction levels
- Nini & Nmax only evaluated at mix design
- Gradation ranges changed slightly
- VFA only a mix design spec
- VMA at mix design raised to14.5, field 13.5
- 92.0 to 96.0 In place density for all levels
- FAA raised to 41.5 on Q2
- Flat and elongated only a spec at mix design
- Mix Designers required to participate in Proficiency Sample Program
- Program started aggregate (Proficiency Sample)

Prior Changes

- Gyratory will be used for D, E, G, HR and composite mix designs
- Security tags needed on all samples delivered by Contractor to Pierre materials lab

Contractor Design Requirements

- Design done using SD 319 and using SDDOT test procedures along with AASHTO and ASTM references
- Mix design must meet all SDDOT requirements and specifications (Special Provisions, standard specs. etc.)
- Furnish mix design including lab data and test results.
- Contractor must maintain calibration records for all lab testing equipment

Aggregate Requirements

- Get legal pit descriptions for all aggregate sources
- Quality tests completed on aggregate sources
- Use average stockpile gradation tests
- Determine proposed trial bin splits

Aggregate Tests Needed Gyratory Control

- Fine Aggregate Angularity (SD 217)
- Sand Equivalent (SD 221)
- Particles less than 1.95 Specific Gravity in Aggregate (Fine is SD 208) (Coarse is SD 214)
- Crushed Particles (Fractured Faces) (SD 211)
- Specific Gravity and Absorption of Aggregates (Fine is SD 209) (Coarse is SD 210)
- LA Abrasion (SD 204)
- Sodium Sulfate Soundness Loss (5 cycles) (SD 220)
- Gradation (SD 202)
- Flat & Elongated Particles (SD 212) - Problem

Problem #1

Flat & Elongated (SD 212)

Given the following gradation, calculate the percent of flat and elongated particles.

Gradation	
Sieve Size	**Retained (g)**
3/4"	0.0
5/8"	0.0
1/2"	227.8
3/8"	696.9
1/4"	1219.8
#4	922.8

	A	B	C	D	E
Sieve Size	**Total Sample Weight on Sieve**	**Weight of Tested Portion** (100 pieces)	**Weight of Flat/Elongated Particles**	**% Flat/Elongated (Individual Sieve)**	**% Flat/Elongated Weighted Average**
3/4" to 1/2"		227.8	5.0		
1/2" to 3/8"		222.2	7.3		
3/8" to #4		61.1	3.0		
Total Sample Wt.		F			

Percent flat and elongated particles
in the total sample (weighted average) ______

rounded ______

Problem #1 - Answer

Flat & Elongated (SD 212)

Gradation	
Sieve Size	Retained (g)
3/4"	0.0
5/8"	0.0
1/2"	227.8
3/8"	696.9
1/4"	1219.8
#4	922.8

Add together

	A	B	C	D	E
Sieve Size	Total Sample Weight on Sieve	Weight of Tested Portion (100 pieces)	Weight of Flat/Elongated Particles	% Flat/Elongated (Individual Sieve)	% Flat/Elongated Weighted Average
3/4" to 1/2"	227.8	227.8	5.0	2.2	0.2
1/2" to 3/8"	696.9	222.2	7.3	3.3	0.7
3/8" to #4	2142.6	61.1	3.0	4.9	3.4
Total Sample Wt.	3067.3	F			

Percent flat and elongated particles in the total sample (weighted average): 4.3

rounded: 4

- **(F)** Total Saple Wt. $= 227.8 + 696.9 + 2142.6 = 3067.3$
- **(D)** % F&E (individual sieve) $= \left(\frac{C}{B}\right) \times 100 = \left(\frac{5.0}{227.8}\right) \times 100 = 2.2$ (1/2")
- $\left(\frac{7.3}{222.2}\right) \times 100 = 3.3$ (3/8") $\quad \left(\frac{3.0}{61.1}\right) \times 100 = 4.9$ (#4)
- **(E)** % F&E (weighted avg) $= \left(\frac{A}{F}\right) \times D = \left(\frac{227.8}{3067.3}\right) \times 2.2 = 0.2$ (1/2")
- $\left(\frac{696.9}{3067.3}\right) \times 3.3 = 0.7$ (3/8") $\quad \left(\frac{2142.6}{3067.3}\right) \times 4.9 = 3.4$ (#4)
- Total % F&E $= 0.2 + 0.7 + 3.4 = 4.3 = 4$ **(rounded)**

Composite Mineral Aggregate Specification Requirements

Vary by traffic level (Q1, Q2, Q3, Q4, Q5)

- With or without hydrated lime
- RAP if required
- Problem

Problem #2

- Q2R mix with 20% RAP to be added by weight of aggregate
- Solvent extraction test result of 6.50% binder in RAP
- 1.00% hydrated lime added by weight of total mix
- Aggregate bin splits
  - 30% Crushed Rock
  - 25% Crushed Fines
  - 30% Natural Fines
  - 15% Sand
- Prepare a 4750 gram batch with 4.5% added new binder by weight of total mix
- Determine amount of added new binder, lime, RAP, rock, crushed fines, natural fines and sand to be added for a gyratory specimen
- Also determine total binder, new (added) and old (RAP) %

Answer Problem #2

- 4750 grams total for gyratory specimen
  - (4750 x 4.5) / 100 = 213.8 grams new binder by weight of total mix
  - (4750 x 1.00) / 100 = 47.5 grams hydrated lime by weight of total mix
  - (47.5 + 213.8) = 261.3 grams
  - (4750 – 261.3) = 4488.7 grams aggregate and RAP
  - (4488.7 x 20) / 100 = 897.7 grams RAP
  - (4488.7 – 897.7) = 3591.0 grams Virgin MA aggr.

    -or- (4488.7 x 80) / 100 = 3591.0 grams Virgin MA aggr.
  - (3591.0 x 30) / 100 = 1077.3 grams crushed rock
  - (3591.0 x 25) / 100 = 897.8 grams crushed fines
  - (3591.0 x 30) / 100 = 1077.3 grams natural fines
  - (3591.0 x 15) / 100 = 538.7 grams sand

Answer Problem #2 (continued)

- Binder from RAP => (897.7 x 6.5) / 100 = 58.4 grams old binder from RAP
- 58.4 grams from RAP + 213.8 grams added binder = 272.2 grams total binder
- (272.2 / 4750) x 100 = 5.73% total binder in mix
- (58.4 / 272.2) x 100 = 21.45% old binder from RAP
- (213.8 / 272.2) x 100 = 78.55% new binder
  - This assumes all old binder is effective. Probably not the case, but effective amount in not able to be determined at this time and varies by mix design.

Hot Mix Design Specifications Gyratory Control

- Air Voids
- Voids in the Mineral Aggregate
- Voids Filled with Asphalt at mix design only
- Densification at N_{ini} , N_{des} and N_{max} mix design
- Densification at N_{des} only in field for spec
- Dust/Binder Ratio (based on effective asphalt content)
- Moisture Sensitivity (TSR ratio) 80 required on all mixes (Q1, Q2, Q3, Q4, Q5). (if 1.00 % lime is not added)

Mixture Tests
Gyratory Control

- Density of Compacted Bit. Mixtures with the gyratory compactor (SD 318)
- Theoretical Maximum Specific Gravity of Uncompacted Bit. Mixtures (SD 312)
- Air Voids Calculation (SD 318)
- Densification at N_{ini} , N_{des} and $_{Nmax}$
- VMA calculation (SD 318)
- Dust/Binder ratio
- Moisture Sensitivity of Compacted Bituminous Specimens (SD 309)

Air Voids Specification

- All Gyratory Control Levels = 4.0 Va unless plan not to change the target
- Air Voids + or – 1.0 % from target, statistically analyzed in the field
- allow for VMA drop when selecting mix design air voids, design for anticipated drop in field air voids

Mix Design Calculations

- Complete all needed calculations
- Determine Air voids, VMA, VFA, Effective AC Content, Marshall Stability and Flow, and Dust/Binder Ratio
- Densification on Gyratory Control (Q1,Q2 etc.)
- PLOT DATA
- Problem

Problem #3

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q3R Mix.

Use the equation sheet in the Problems Packet.

Mix Temp	275

			No. of gyrations		
% binder Pb	6.0	**N initial**		**Gse**	
Gsb	2.554	**N design**		**Pba**	
binder Gb	1.024	**N max**		**Pbe**	
dust (- #200)	4.69				
lime	1.00				
dust(-#200) + lime					

	Spec. A (Ndes)		Spec. B (Ndes)				
	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm	122.6	114.5	124.7	116.3	124.7	116.1	114.9
b) Weight in air		4697.7		4698.9			4696.8
c) Weight in water		2667.0		2668.2			2687.3
d) SSD Weight		4699.2		4700.4			4697.4
e) Gmb (measured) b / (d - c)							
f) Gmb (calculated)							

	Gmm #1	Gmm #2
Weight of sample in air	1545.1	1534.2
Weight of canister + H_2O	1365.4	1365.4
Weight of canister + H_2O + sample	2271.5	2264.1
Temperature of water	77.0	78.0
H_2O correction factor	1.0000	0.9999
Rice SpGr (Gmm)		

Average Max SpGr (Gmm)

	N initial	N design	N maximum
Average Gmb			
% of Rice SpGr (Gmm)			

% Air Voids (Va)		**% VMA**		**% VFA**		**Dust to Binder Ratio**	
Specs:							

Problem #3

DOT-86
Gyratory Worksheet

$$\textbf{dust}\ (-\#200) + \textbf{lime} = 4.69 + 1.00 = \mathbf{5.7}$$

$$\boldsymbol{Spec.A}:\ \textbf{Gmb measured} = \frac{\mathrm{b}}{(\mathrm{d}-\mathrm{c})} = \frac{4697.7}{(4699.2 - 2667.0)} = \mathbf{2.312}$$

$$\boldsymbol{Spec.B}:\ \textbf{Gmb measured} = \frac{\mathrm{b}}{(\mathrm{d}-\mathrm{c})} = \frac{4698.9}{(4700.4 - 2668.2)} = \mathbf{2.312}$$

$$\boldsymbol{Spec.A}:\ \textbf{Gmb calculated} = \frac{(\mathrm{Gmb(meas)} \times \mathrm{height\ @\ Ndes})}{(\mathrm{height\ @\ Nini})} = \frac{(2.312 \times 114.5)}{122.6} = \mathbf{2.159}$$

$$\boldsymbol{Spec.B}:\ \textbf{Gmb calculated} = \frac{(\mathrm{Gmb(meas)} \times \mathrm{height\ @\ Ndes})}{(\mathrm{height\ @\ Nini})} = \frac{(2.312 \times 116.3)}{124.7} = \mathbf{2.156}$$

$$\text{Average Gmb @ Ninitial} = \frac{(2.159 + 2.156)}{2} = 2.158$$

$$\text{Average Gmb @ Ndesign} = \frac{(2.312 + 2.312)}{2} = 2.312$$

No. of gyrations

- Spec. Book Sect. 322 (Q3R – Table G)
  - $N_{initial} = 6$
  - $N_{design} = 60$
  - $N_{max} = 85$

Problem #3

DOT-86
Gyratory Worksheet

$$@\ \mathbf{N\ max:}\quad \mathbf{Gmb\ measured} = \frac{b}{(d-c)} = \frac{4696.8}{(4697.4 - 2687.3)} = \mathbf{2.337}$$

$$\mathbf{N\ max\ (@\ N\ ini):}\quad \mathbf{Gmb\ calculated} = \frac{(\text{Gmb(meas)} \times \text{height @ Nmax})}{(\text{height @ Nini})} = \frac{(2.337 \times 114.9)}{124.7} = \mathbf{2.153}$$

$$\mathbf{N\ max\ (@\ N\ des):}\quad \mathbf{Gmb\ calculated} = \frac{(\text{Gmb(meas)} \times \text{height @ Nmax})}{(\text{height @ Ndes})} = \frac{(2.337 \times 114.9)}{116.1} = \mathbf{2.313}$$

$$\mathbf{Average\ Gmb\ @\ Nmax} = \mathbf{2.337}$$

Problem #3

DOT-86

Gyratory Worksheet

$$\textbf{Rice SpGr} = \left[\frac{\text{wt.of sample in air}}{(\text{wt.of sample in air}) + (\text{wt.of canister} + H_2O) - (\text{wt.of canister} + H_2O + \text{sample})}\right] \times \text{Corr. Factor}$$

$$\text{Gmm \#1} = \left[\frac{1545.1}{(1545.1 + 1365.4 - 2271.5)}\right] \times 1.0000 = \mathbf{2.418}$$

$$\text{Gmm \#2} = \left[\frac{1534.2}{(1534.2 + 1365.4 - 2264.1)}\right] \times 0.9999 = \mathbf{2.414}$$

$$\text{Average Max SpGr (Gmm)} = \frac{(2.418 + 2.414)}{2} = \mathbf{2.416}$$

$$\text{\% of Rice SpGr (Gmm) @ Ninitial} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.158}{2.416} \times 100 = \mathbf{89.3}\ \%$$

$$\text{\% of Rice SpGr (Gmm) @ Ndesign} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.312}{2.416} \times 100 = \mathbf{95.7}\ \%$$

$$\text{\% of Rice SpGr (Gmm) @ Nmax} = \frac{\text{Avg. Gmb}}{\text{Avg. Max SpGr}} \times 100 = \frac{2.337}{2.416} \times 100 = \mathbf{96.7}\ \%$$

Problem #3

DOT-86
Gyratory Worksheet

$$\% \textbf{ Air Voids (Va)} = \left(\frac{\text{Gmm} - \text{Gmb}}{\text{Gmm}}\right) \times 100 = \left(\frac{2.416 - 2.312}{2.416}\right) \times 100 = \mathbf{4.3\%}$$

$$\textbf{Ps} = 100 - \text{Pb} = 100 - 6.0 = \mathbf{94.0\,\%}$$

$$\% \textbf{ VMA} = 100 - \left(\frac{\text{Gmb} \times \text{Ps}}{\text{Gsb}}\right) = 100 - \left(\frac{2.312 \times 94.0}{2.554}\right) = \mathbf{14.9\,\%}$$

$$\% \textbf{ VFA} = \left(\frac{\text{VMA} - \text{Va}}{\text{VMA}}\right) \times 100 = \left(\frac{14.9 - 4.3}{14.9}\right) \times 100 = \mathbf{71\,\%\ (whole\ percent)}$$

$$\textbf{Gse} = \frac{100 - \text{Pb}}{\left(\frac{100}{\text{Gmm}}\right) - \left(\frac{\text{Pb}}{\text{Gb}}\right)} = \frac{100 - 6.0}{\left(\frac{100}{2.416}\right) - \left(\frac{6.0}{1.024}\right)} = \mathbf{2.646}$$

Problem #3

DOT-86
Gyratory Worksheet

$$\textbf{Pba} = 100 \times \left(\frac{\text{Gse} - \text{Gsb}}{\text{Gse} \times \text{Gsb}}\right) \times \text{Gb} = 100 \times \left(\frac{2.646 - 2.554}{2.646 \times 2.554}\right) \times 1.024 = \mathbf{1.4\,\%}$$

$$\textbf{Pbe} = \text{Pb} - \left(\frac{\text{Pba} \times \text{Ps}}{100}\right) = 6.0 - \left(\frac{1.4 \times 94.0}{100}\right) = \mathbf{4.7\,\%}$$

$$\textbf{Dust to Binder Ratio} = \left(\frac{\text{dust} - \#200 + \text{lime}}{\text{Pbe}}\right) = \left(\frac{5.7}{4.7}\right) = \mathbf{1.2}$$

Specs: **Spec Book - Sect. 322 (Q3R mix)**

- TABLE L (% Air Voids) → **4.0% ± 1.0%**
- TABLE I (% VMA) → **minimum 14.5%**
- TABLE J (% VFA) → **65% – 78%**
- Dust to Binder Ratio → **0.6 to 1.4 -or- 0.8 to 1.6 (depends on gradation @ mix design)**

Problem #3

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q3R Mix.

Use the equation sheet in the Problems Packet.

Mix Temp	275							
				No. of gyrations				
% binder Pb	6.0		**N initial**	6		**Gse**	2.646	
Gsb	2.554		**N design**	60		**Pba**	1.4	
binder Gb	1.024		**N max**	85		**Pbe**	4.7	
dust (- #200)	4.69							
lime	1.00	**Spec. A (Ndes)**		**Spec. B (Ndes)**				
dust(-#200) + lime	5.7	@ N ini	@ N des	@ N ini	@ N des	@ N ini	@ N des	@ N max
a) Height, mm		122.6	114.5	124.7	116.3	124.7	116.1	114.9
b) Weight in air			4697.7		4698.9			4696.8
c) Weight in water			2667.0		2668.2			2687.3
d) SSD Weight			4699.2		4700.4			4697.4
e) Gmb (measured)	b / (d - c)		2.312		2.312			2.337
f) Gmb (calculated)		2.159		2.156		2.153	2.313	

	Gmm #1	Gmm #2
Weight of sample in air	1545.1	1534.2
Weight of canister + H_2O	1365.4	1365.4
Weight of canister + H_2O + sample	2271.5	2264.1
Temperature of water	77.0	78.0
H_2O correction factor	1.0000	0.9999
Rice SpGr (Gmm)	2.418	2.414

Average Max SpGr (Gmm) 2.416

	N initial	**N design**	**N maximum**
Average Gmb	2.158	2.312	2.337
% of Rice SpGr (Gmm)	89.3	95.7	96.7
			≤ 98.0

% Air Voids (Va)	4.3	**% VMA**	14.9	**% VFA**	71	**Dust to Binder Ratio**	1.2
Specs:	4.0 ± 1.0		14.5 min		65 - 78		0.6 – 1.4 -or- 0.8 – 1.6

Mix Design Reports

- Submit all lab aggregate test data
- Submit all lab mix design test data
- Submit lab graphs
- Contractor Recommended Job Mix Formula and Asphalt Binder Content

Mix Design Verification Submittal to SDDOT

- Materials to **PIERRE DOT MATERIALS LAB on Truck Route (104 S Garfield Ave Bldg. B)** at least 21 calendar days prior to hot mix production
- Provide aggregate stockpile tests per 1500 tons of material produced (certified testers)
- Label all materials (aggregate and binder)
- Include legal descriptions of all materials
- DOT Area Office witness and send in samples or secure samples (green security tags) if Contractor brings to Pierre

Submitted Aggregate To SDDOT

- Must be representative of stockpiles produced or will need to resubmit samples
- Sample size is large enough to do all required mix and quality tests
- Submitted by contractor or representative when secured by SDDOT field tags to Bituminous mix design section in Pierre

Aggregate Data Needed

- Average stockpile gradations
- legal pit descriptions of the stockpiles
- +#4 and -#4 bulk sp. gr. of each stockpile
- Quality tests on the aggregates
- bin splits to be used
- Combined bulk sp.gr. of the composite aggregate

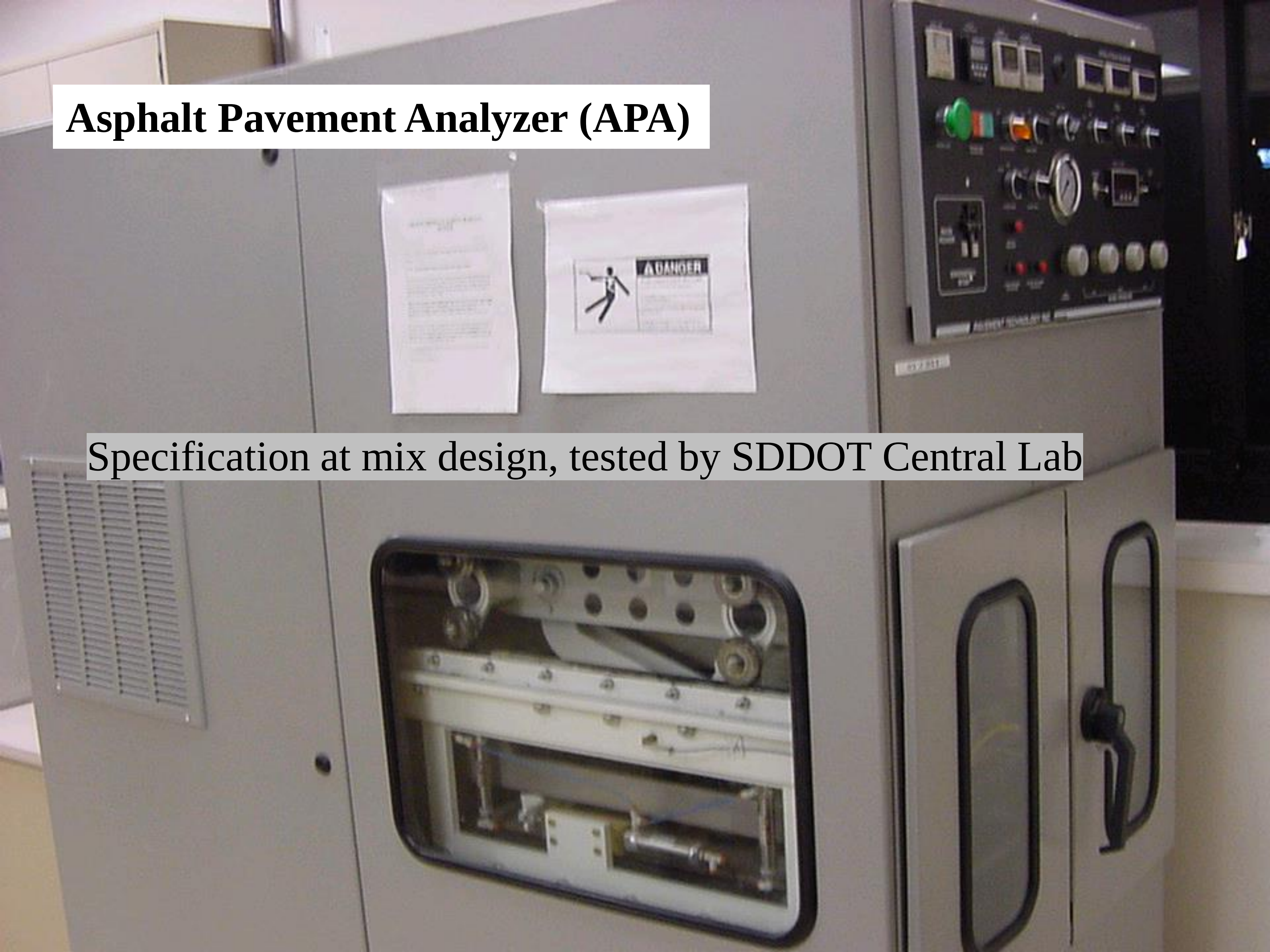
RAP Testing

- 1 per day for gradation (100% passing 1 ½” and 95-100 passing 1”) & moisture content
- 1 daily RAP content (end of day)

SDDOT Verification

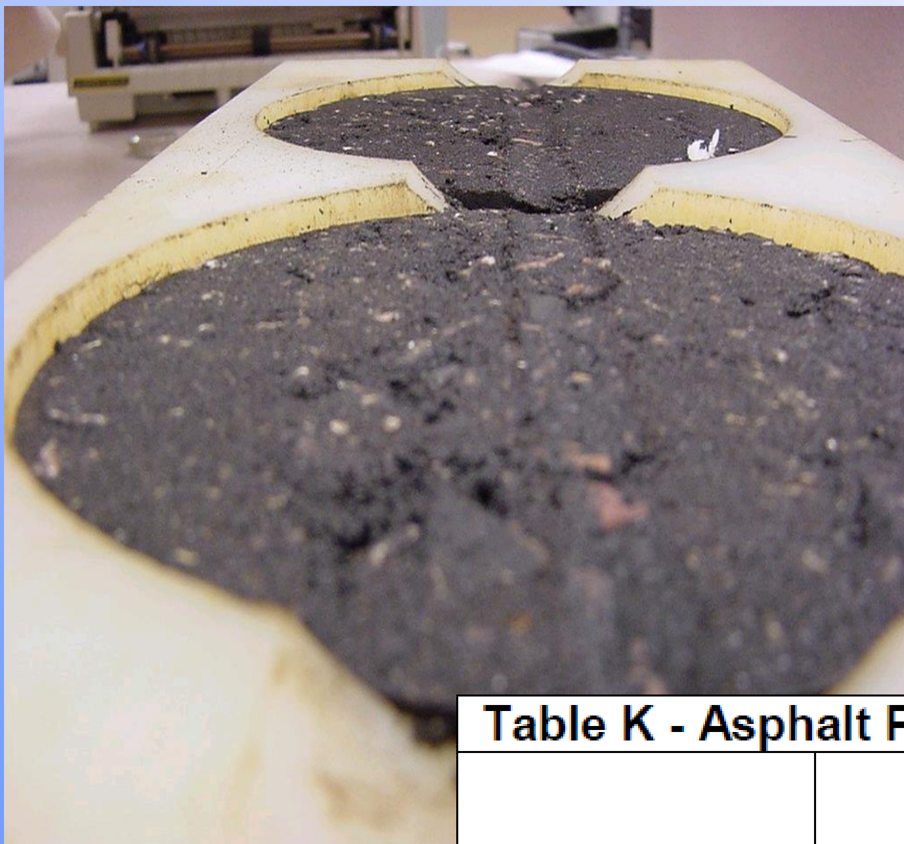
- Aggregate and binder submitted
- DOT conducts aggregate quality tests
- DOT does mix design verification
- DOT does moisture sensitivity verification
- Send out Mix Design Report (DOT-64)
  - fax to Contractor and DOT Area Office
  - * e-mail to Contractor and DOT Area Office

Asphalt Pavement Analyzer (APA)



Specification at mix design, tested by SDDOT Central Lab

Asphalt Pavement Analyzer (APA) - Specs



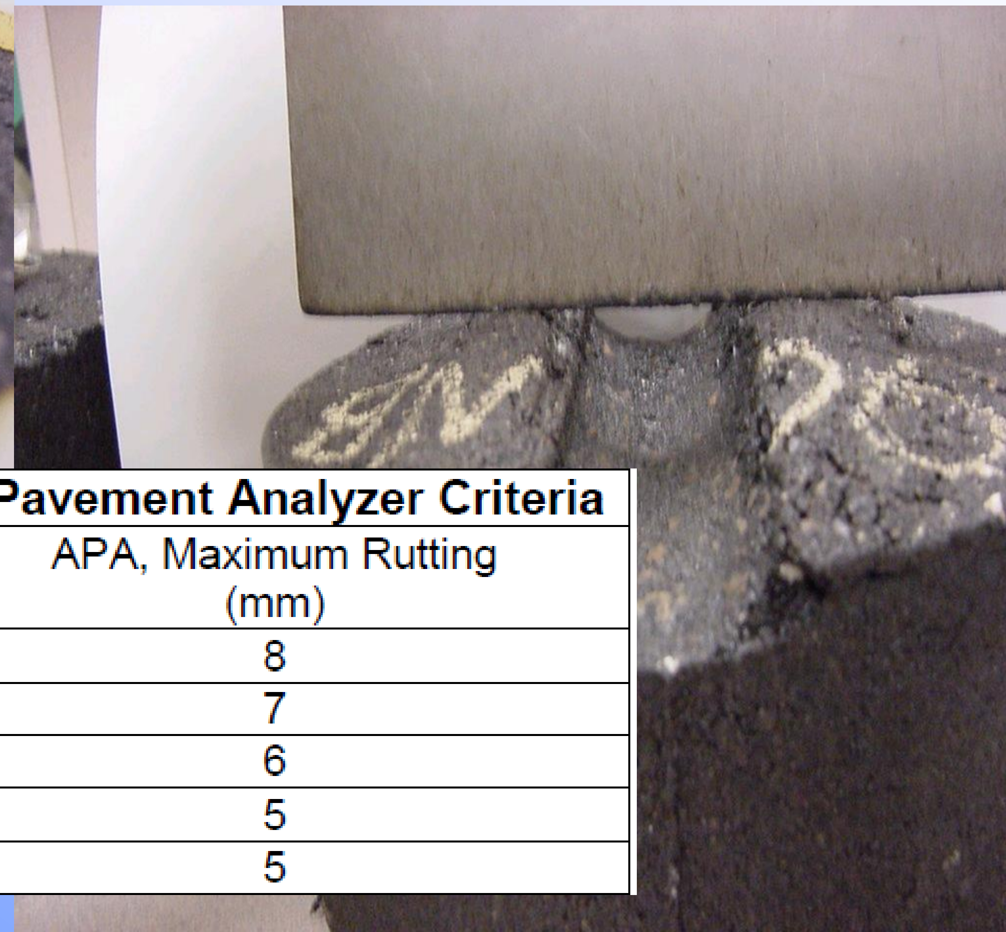


Table K - Asphalt Pavement Analyzer Criteria	
	APA, Maximum Rutting (mm)
Class Q1	8
Class Q2	7
Class Q3	6
Class Q4	5
Class Q5	5

Field Correlation Testing
Gyratory Control

- Sample supplied by contractor, may be plant produced if spot leveling, Spec. Prov. Page 10
- Gyratory Compaction at N_{des} (SD 318)
- Theoretical Max Sp. Gr., Rice (SD 312)
- Air Void calculation on form (SD 318)

Field Samples

- Location, sample obtained from windrow at paver at a random location, (SD 312)
- Sample size , enough for 4 splits, large enough for all tests required
- Split down to testing size, quartering method
- Frequency of needed tests, QC 1 per 1,000 tons, minimum QA 1 per 5,000 tons, IA one per 15,000 tons
- Retention of split portions of samples, QA until F and t tests completed by Bituminous Engineer

Field Bulk Specific Gravity Reheat Correlation

- Within First Lot of material
- Cool to room temperature, reheat to compaction temperature
- Used for IA tolerances and if QC vs. QA correlation problems occur
- Shows aggregate and asphalt mixture absorption rates

Moisture in the Mix

- Field test required at start of project and once per 10,000 tons of hot mix produced
- SDDOT sampled from windrow in front of paver*
- Warm Mix Research Project

Field Production Control Charts

- QC maintains charts for all required properties shown in Specifications
- Contractor (QC) is responsible for maintaining all process control charts and adding QA and IA tests to charts

Field (Mix) Problems

- Air Voids Problems
- Density Problems
- Gradation Problems
  - Job mix formula tolerances (Spec. Book – Sect. 322, Table N)
  - Quality (Fractured Faces, Lightweights, FAA, Sand Equivalent, Flat & Elongated)
- Other Problems (segregation, lime, comparisons, etc.)

Air Void Problems

- Low Voids
  - Drop in VMA
  - Increase in amount passing -#200 sieve
- High Voids
  - Low binder content
  - Change aggregate gradation
  - No lime
- Variable voids
  - Mix design
  - Plant
  - Aggregates
  - Lime

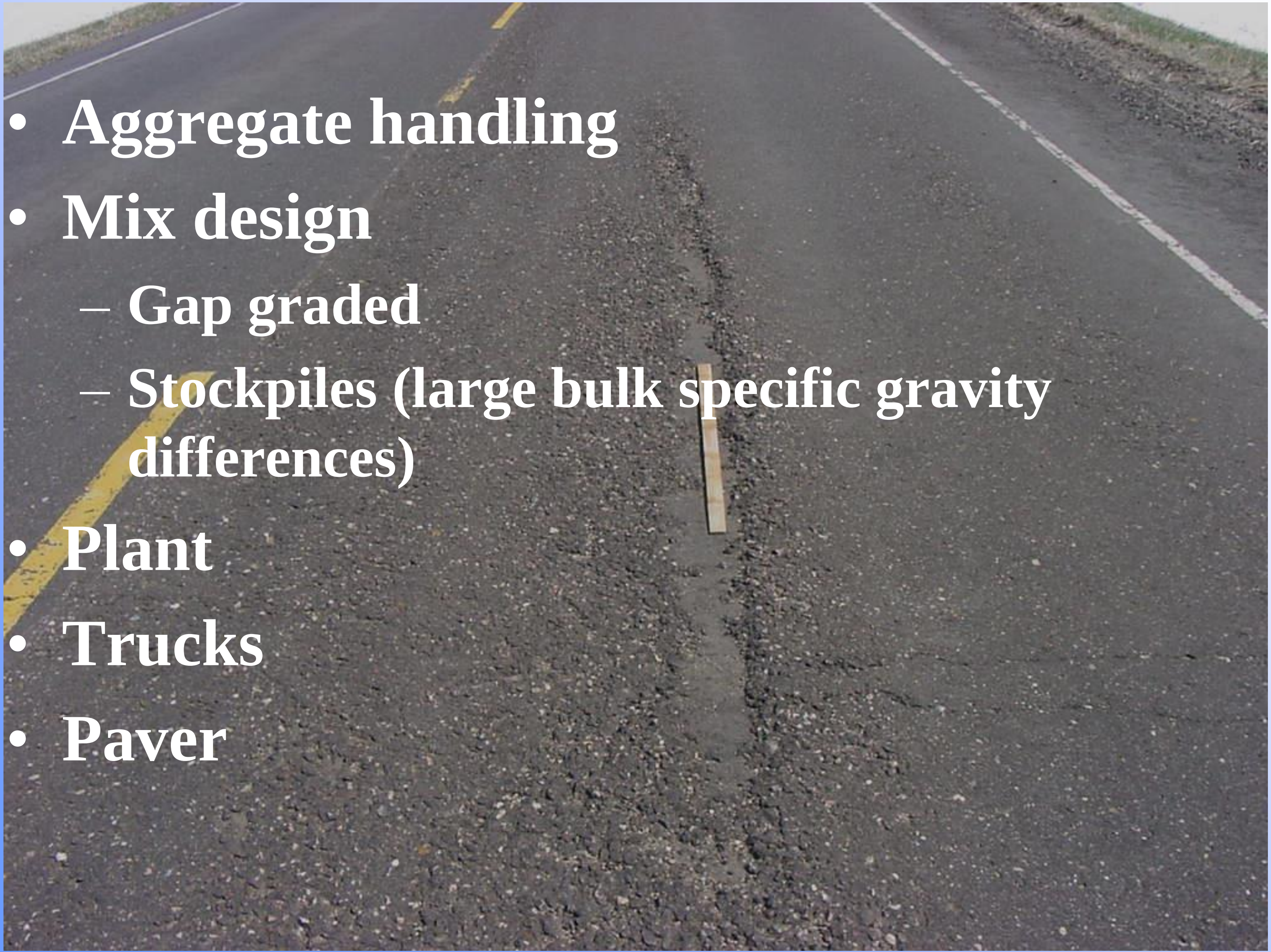
In-Place Density Problems

- High gyratory air voids
- Low VMA
- Mix workability
- Not measuring field in-place density
- Temperature of mix at time of compaction rolling is too low or not uniform
- Mix instability
- Base problems
- Compaction equipment problems or not enough rollers

Gradation Problems

- Incorrect or inconsistent stockpile gradations
- Variable or segregated stockpiles
- Insufficient stockpile samples at design
- Bin splits incorrect
- Improper loading of cold bins
- Inconsistent feeds from the cold bins
  - wet material sticking in or bridging bins

Segregation



- Aggregate handling
- Mix design
  - Gap graded
  - Stockpiles (large bulk specific gravity differences)
- Plant
- Trucks
- Paver

*Must be completed before QA discards back-up samples

F and t tests (Example)

avg	2.446	2.347	4.04	avg	2.445	2.348	4.00	avg	2.447	2.348	4.10
stdev	0.0059	0.0044	0.277	stdev	0.0049	0.0052	0.367	stdev	0.0117	0.00208	0.436
F-test	0.7973	0.5263	0.34	F-test	0.1398	0.288	0.689	F-test	0.06936	0.40246	0.21
	between QC AND QA				between QA AND IA				between IA AND QC		
0.01	OK	OK	OK		OK	OK	OK		OK	OK	OK
0.05	OK	OK	OK		OK	OK	OK		OK	OK	OK
t-test	0.7696	0.8713	0.76	t-test	0.69848	0.9841	0.739	t-test	0.71214	0.87043	0.76
0.01	OK	OK	OK		OK	OK	OK		OK	OK	OK
t-test	0.7696	0.8713	0.76	t-test	0.69848	0.9841	0.739	t-test	0.71214	0.87043	0.76
0.05	OK	OK	OK		OK	OK	OK		OK	OK	OK

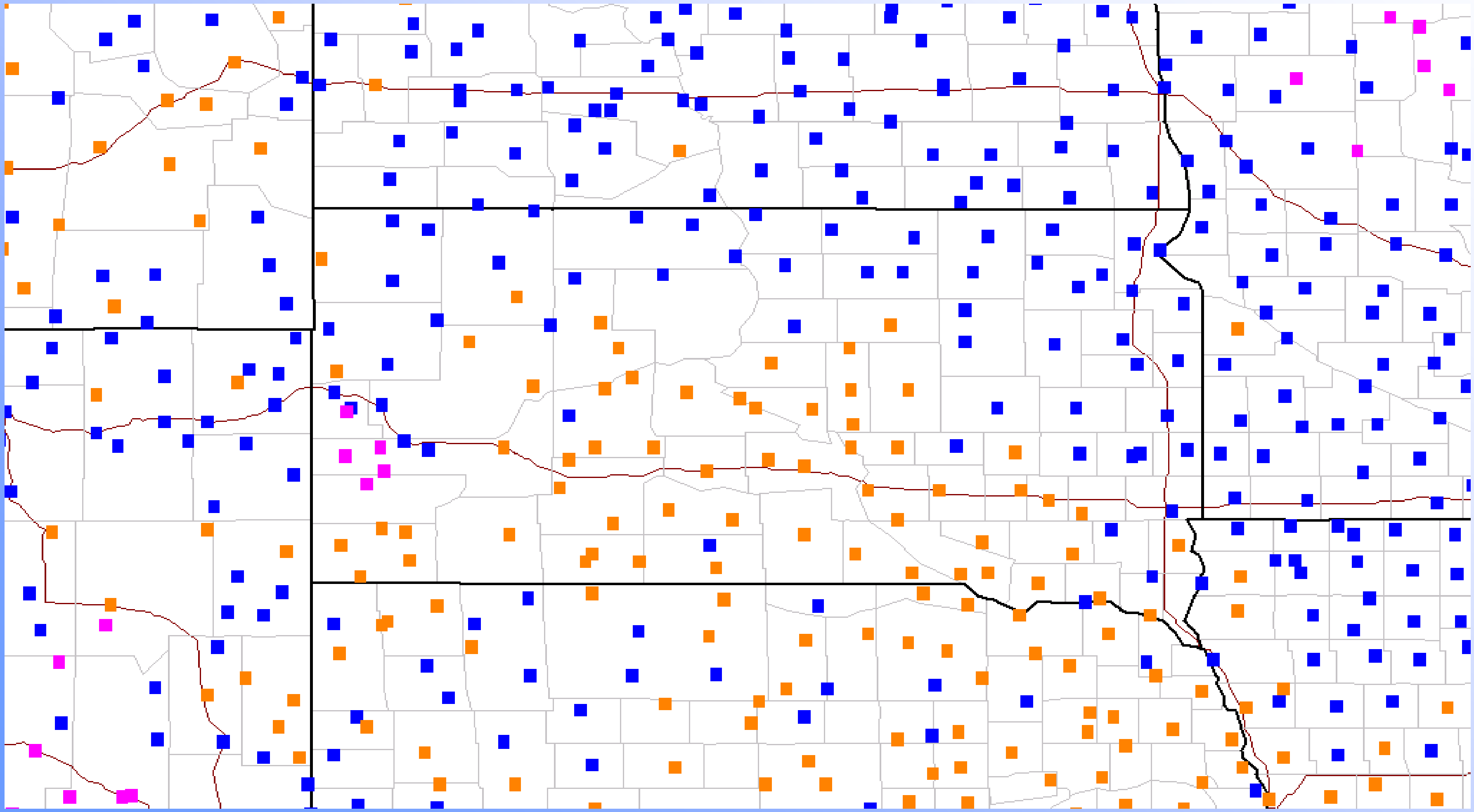
Future Changes?

- Fatigue tests SCB and DCT
- Intelligent Compaction Special Provision
- Longitudinal joint specification
- Ride specification changes (Areas of Localized Roughness)
- MSCR binder test (CSBG spec)
- Dynamic modulus MEPDG
- Hamburg test

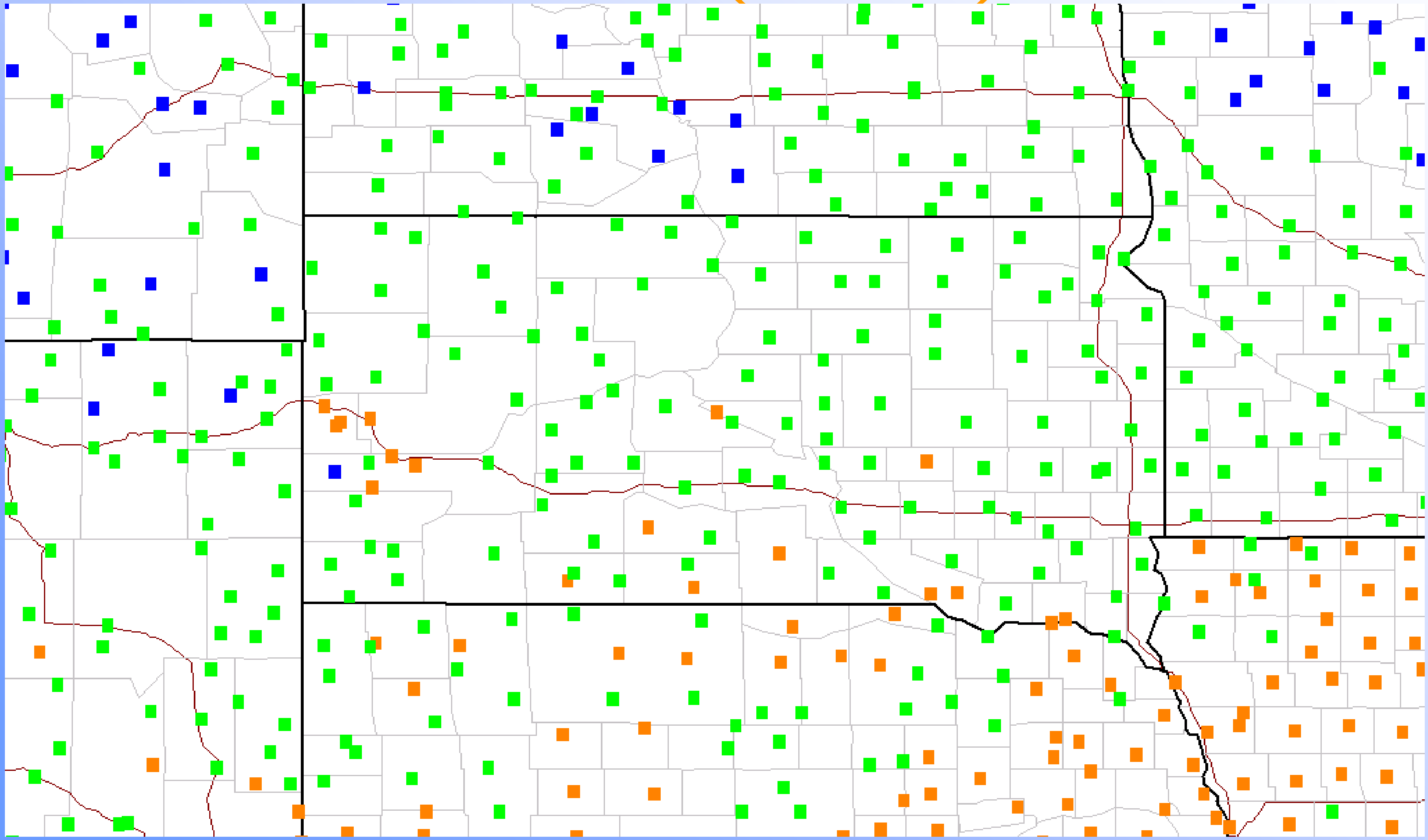
Binder Testing

- Binder specification changes in the future
  - MSCR test procedure instead of elastic Recovery (AASHTO T350)
- AASHTO M322 Specification
  - Different system to select binder i.e. grade bumping by using the following
  - S (standard), H (high), V (very high), E (extremely high)
  - 20 choices of binder grade

High temperature 58°C (136°F) 64°C (147°F)



Low temperature -34°C (-29°F) -28°C (-18°F)

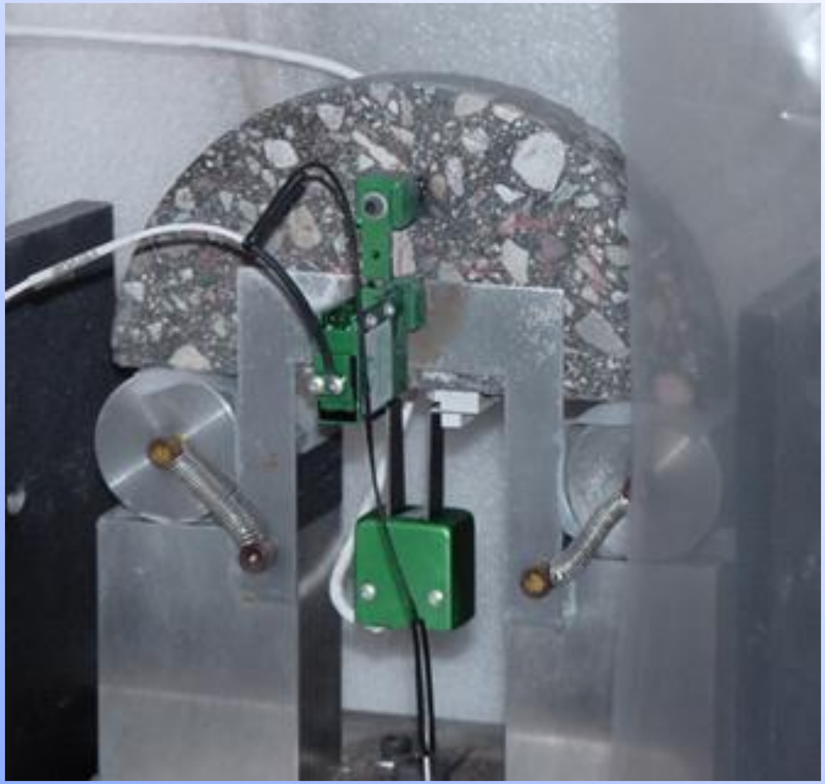


South Dakota (20 year ESALs)

- 0 to 300,000 ESALs 3865 miles
- 300,000 to 1,000,000 ESALs 3046 miles
- 1,000,000 to 3,000,000 ESALs 1528 miles
- 3,000,000 to 10,000,000 ESALs 276 miles
- over 10,000,000 ESALs 0 miles
  - All of SDDOT roads are in Standard "S" binder grade

Low Temperature Cracking Resistance

- DCT test, Disc-Shaped Compact Tension test
- SCB test, Semi-Circular Bend Test
- Purchased equipment 2016

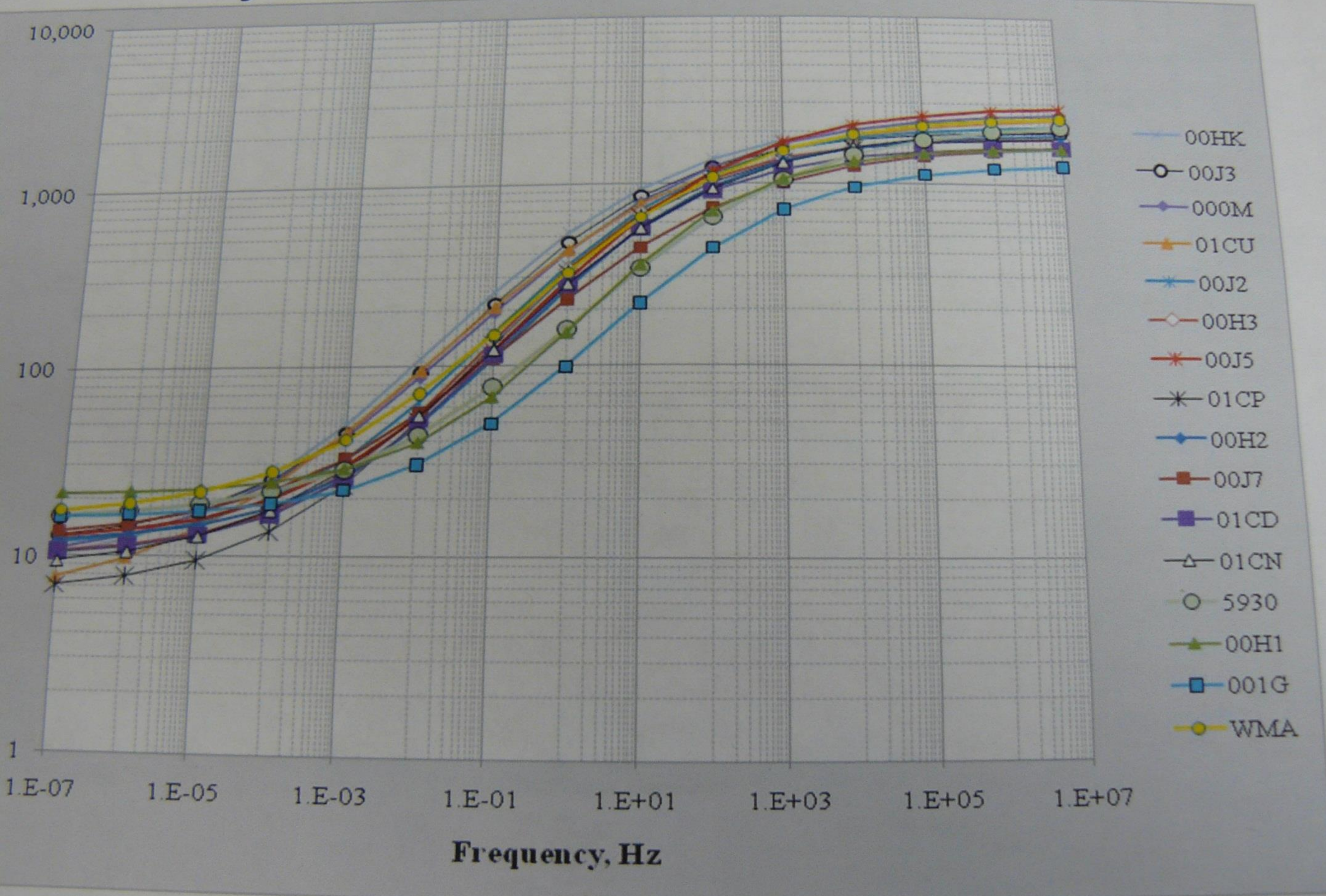


DCT & SCB Testing Equipment

MEPDG

- 6 Projects per year
- SDSM&T

Dynamic Modulus Testing



MEPDG

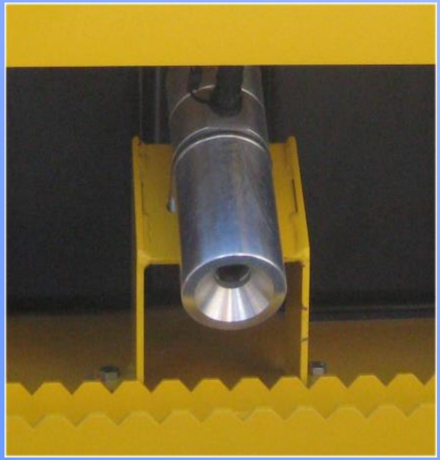
- MEPDG works from individual materials tests or catalogue of test results data
- Input data AMPT test results
- Input Mr (ksi) subgrade
- Input Mr (ksi) base
- Input asphalt thickness

- Determine if meets design requirements on predicted performance
- If not, enter with new asphalt thickness

Intelligent Compaction

Control Panel

GPS Radio/Receiver



Temperature Sensor

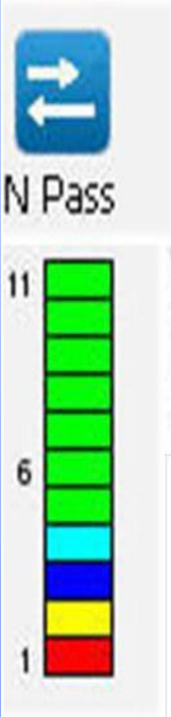
Accelerometer

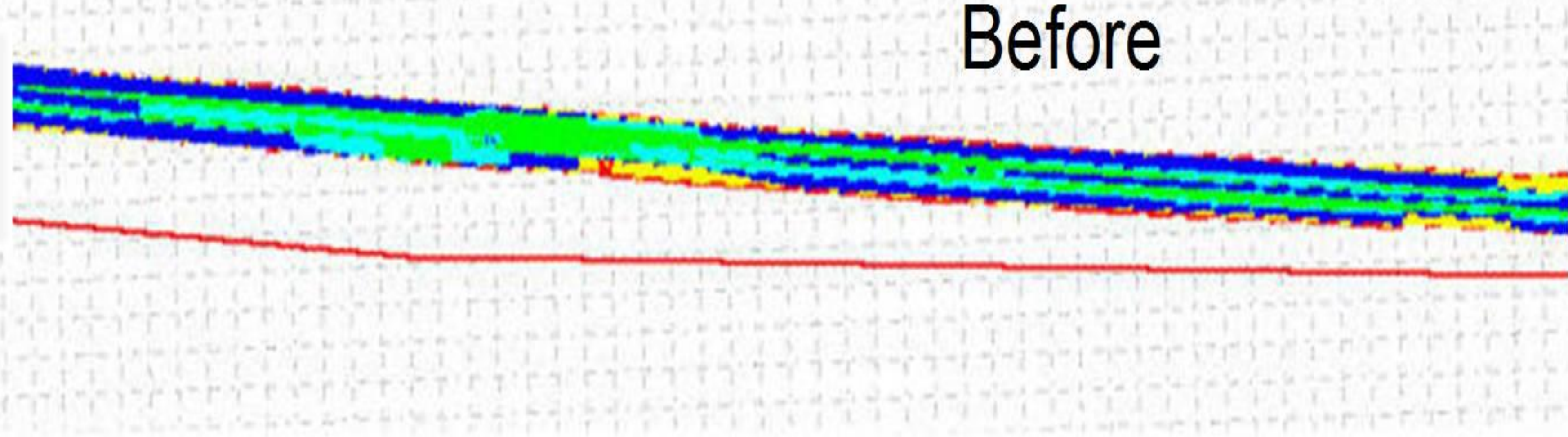
CIS Display

Intelligent Compaction

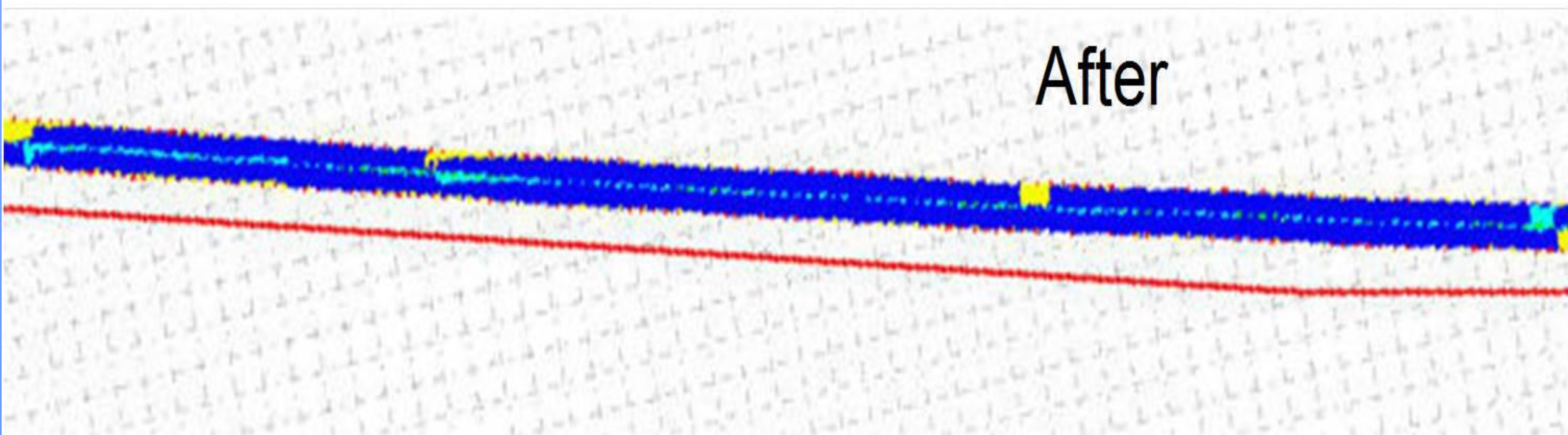
38 orbiting satellites

Rover base stations every 2 miles





Intelligent Compaction



Hamburg Wheel-Tracking Test Device

- Moisture resistance
- Rutting

Q2 PG 64-22

Hamburg Wheel-Tracking Test - Results

Q3 PG 64-34 binder

Hamburg Wheel-Tracking Test - Results

Future Changes? (continued)

- Approved Product lists
  - Warm mix additives
  - Release agents
  - Crack sealants, Research Project
- Chip Seal Special Provision
  - Design and compatibility requirements
- Revised Micro-surfacing Special Provision
- Micro-milling Specification
- Balanced Mix Design (uses performance tests)

Micro-milling Special Provision used on US16 in Custer Area (2016)

Recertification Exam

- Once the exam has started, you will have 2 hours to complete the exam.
- The Exam is open book/notes (Standard Specifications for Roads and Bridges – 2015, QC/QA Asphalt Concrete Training Manual and the Materials Manual)
- A score of 70% or better is required to pass the exam.